1. A method of positioning a movable body suspended in a magnetic bearing system comprising a displacement sensor, comprising:

measuring the axial position of the movable body with the sensor to produce a displacement output;

adjusting the displacement output to account for a sensor offset;

converting the adjusted displacement output to a force for positioning the movable body; and

and positioning the movable body with said force.

2. The method of claim 1, wherein converting the adjusted displacement output to a force comprises inputting the adjusted displacement output into a position controller configured to determine the point of substantial axial equilibrium of the movable body.

3. The method of claim 2, wherein converting the adjusted displacement output to a force for positioning the movable body comprises creating a mechanical force to position the movable body at the point of substantial axial equilibrium.

4. The method of claim 2, wherein converting the adjusted displacement output to a force for positioning the movable body comprises creating an electromagnetic force to position the movable body at the point of substantial axial equilibrium.

5. The method of claim 1, wherein adjusting the displacement output to account for the sensor offset comprises estimating the sensor offset and adjusting the displacement output by the estimated sensor offset.

6. The method of claim 5, wherein estimating the sensor offset further comprises storing a plurality of displacement outputs over a period of time.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

7. The method of claim 6, wherein the period of time is determined by comparing a variance of the plurality of displacement output against a predetermined threshold to determine a start time and an end time.

8. The method of claim 6, wherein a selective plurality of displacement outputs are used to estimate the sensor offset, the displacement offsets being selected by comparing a magnitude of the displacement offset against a predetermined threshold.

9. The method of claim 6, wherein estimating the sensor offset further comprises taking an average value of the stored displacement outputs.

10. The method of claim 6, wherein estimating the sensor offset further comprises taking an weighted average value of the stored displacement outputs.

11. The method of claim 6, wherein estimating the sensor offset further comprises determining a median value of the stored displacement outputs.

12. The method of claim 6, wherein estimating the sensor offset further comprises determining the mode value of the stored displacement outputs.

13. The method of claim 5, wherein the magnetic bearing system further comprises memory for storing displacement outputs.

14. The method of claim 13, further comprising storing the estimated sensor offset in memory.

15. The method of claim 13, further comprising storing adjusted displacement outputs in memory.

Sub. 6'

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

16. The method of claim 14, further comprising recalling the estimated sensor offset and utilizing the estimated sensor offset to position the movable body to a point of substantial axial equilibrium.

17. The method of claim 15, further comprising recalling the adjusted displacement output and utilizing the adjusted displacement output to position the movable body to a point of substantial axial equilibrium.

18. The method of claim 1, wherein measuring comprises measuring the axial position of the movable body when it is levitating.

a'

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

19. A method of positioning a movable body suspended in a magnetic bearing system comprising a displacement sensor, comprising:

measuring the displacement of the movable body with the sensor to produce an displacement output;

estimating a sensor offset using the displacement output;

adjusting the displacement output by the estimated sensor offset to create an adjusted displacement output;

inputting the adjusted displacement output into a body position controller configured to determine the point of substantial axial equilibrium of the movable body;

converting the adjusted displacement output to an electromagnetic force for positioning the movable body;

positioning the movable body to a point of substantial axial equilibrium; and

repeating the previous steps.

20. The method of claim 19, wherein estimating the sensor offset further comprises storing a plurality of displacement outputs over a period of time, the plurality of displacement outputs being derived from axial position measurements of the movable body.

21. The method of claim 20, wherein the period of time is determined by comparing a variance of the plurality of displacement output against a predetermined threshold to determine a start time and an end time.

22. The method of claim 20, wherein a selective plurality of displacement outputs are used to estimate the sensor offset, the displacement offsets being selected by comparing a magnitude of the displacement offset against a predetermined threshold.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

23. The method of claim 20, wherein estimating the sensor offset further comprises taking an average value of the stored displacement outputs.

24. The method of claim 20, wherein estimating the sensor offset further comprises taking an weighted average value of the stored displacement outputs.

25. The method of claim 20, wherein estimating the sensor offset further comprises determining a median value of the stored displacement outputs.

26. The method of claim 20, wherein estimating the sensor offset further comprises determining the mode value of the stored displacement outputs.

27. The method of claim 19, wherein the magnetic bearing system further comprises memory for storing data.

28. The method of claim 27, further comprising storing the estimated sensor offset in memory.

29. The method of claim 28, further comprising recalling the estimated sensor offset and utilizing said offset to position the movable body to a point of substantial axial equilibrium during a reset of the system.

30. The method of claim 20, further comprising storing the adjusted displacement outputs in memory.

31. The method of claim 30, further comprising recalling the adjusted displacement output and utilizing the adjusted displacement output to position the movable body to a point of substantial axial equilibrium.

32. The method of claim 19, wherein measuring comprises measuring the movable body when it is levitating.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

a'

33. A system for positioning a movable body suspended in a magnetic bearing apparatus, the system comprising:

a sensor for measuring the displacement of the movable body and providing a displacement output;

a sensor offset compensation module, configured to receive said displacement output from the sensor and adjust said displacement output to account for a sensor offset;

a position control module configured to receive and use the adjusted displacement output of the sensor offset compensation module to approximate the point of substantial axial equilibrium of the movable body; and

an actuator module for converting an output of the position control module into a force for positioning the movable body to the point of substantial axial equilibrium.

34. The system of claim 33, wherein the sensor is configured to convert the displacement output to a displacement voltage.

35. The system of claim 33, wherein the sensor offset compensation module is configured to provide an estimated sensor offset and adjust the displacement output by the estimated sensor offset to create an adjusted displacement output.

36. The system of claim 35, wherein the sensor offset compensation module is configured to store a plurality of displacement outputs over a period of time, the plurality of displacement outputs being derived from axial position measurements of the positioned movable body.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

a'

37. The system of claim 36, wherein the sensor offset compensation module compares a variance of the plurality of displacement outputs against a predetermined threshold to determine a start time and an end time.

38. The system of claim 36, wherein a selective plurality of displacement outputs are used to estimate the sensor offset, the displacement offsets being selected by comparing a magnitude of the displacement offset against a predetermined threshold.

39. The system of claim 36, wherein the sensor offset compensation module estimates the sensor offset by taking an average value of the stored displacement outputs.

40. The system of claim 36, wherein the sensor offset compensation module estimates the sensor offset by taking an weighted average value of the stored displacement outputs.

41. The system of claim 36, wherein the sensor offset compensation module estimates the sensor offset by determining a median value of the stored displacement outputs.

42. The system of claim 36, wherein the sensor offset compensation module estimates the sensor offset by determining the mode value of the stored displacement outputs.

43. The system of claim 33, wherein the actuator module is configured to convert the output from the position control module to create a mechanical force to position the movable body to the point of substantial axial equilibrium.

44. The system of claim 33, wherein the actuator module is configured to convert the output from the position control module to create an electromagnetic force to position the movable body to the point of substantial axial equilibrium.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

45. The system of method of claim 33, wherein the magnetic bearing system further comprises memory for storing data.

46. The system of claim 45, wherein the memory stores an estimated sensor offset in memory.

47. The system of claim 46, wherein the position control module uses the estimated sensor offset stored in memory to position the movable body to a point of substantial axial equilibrium during a reset of the system.

48. The system of claim 45, wherein the memory stores an adjusted displacement output in memory.

49. The system of claim 46, wherein the position control module uses the adjusted displacement output stored in memory to position the movable body to a point of substantial axial equilibrium during a reset of the system.

a'

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

a'

50. A method of positioning a magnetically suspended rotor in a pump apparatus, the pump apparatus comprising at least one permanent magnet, at least one electro magnet, a rotor position sensor, and a rotor position controller, comprising:

measuring the displacement of the rotor in the axial direction with the sensor to produce a displacement output;

converting the displacement output into a displacement voltage;

estimating a sensor offset using the displacement output;

adjusting the displacement output by the estimated sensor offset to create an adjusted displacement output;

inputting the adjusted displacement output into the rotor position controller configured to determine the point of substantial axial equilibrium of the rotor;

converting the output of the rotor position controller into an electromagnetic force;

positioning the rotor to a point of substantial axial equilibrium by adjusting the voltage to the electromagnet; and

repeating the previous steps.

51. The method of claim 50, further comprising storing the estimated sensor offset in memory.

52. The method of claim 51, further comprising recalling the estimated sensor offset and utilizing said offset to position the movable body to a point of substantial axial equilibrium during a reset of the system.

53. The method of claim 50, further comprising storing the adjusted displacement output in memory.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

54. The method of claim 53, further comprising recalling the adjusted displacement output and utilizing said offset to position the movable body to a point of substantial axial equilibrium during a reset of the system.

55. The method of claim 50, wherein estimating the sensor offset further comprises averaging a plurality of stored displacement outputs, said plurality of displacement outputs being derived by measuring the displacement of the positioned rotor over a period of time.

56. The method of claim 55, wherein the sensor offset compensation module compares a variance of the plurality of displacement outputs against a predetermined threshold to determine a start time and an end time.

57. The method of claim 56, wherein the sensor offset compensation module estimates the sensor offset by taking an average value of the displacement outputs stored between the start time and the end time.

58. The method of claim 50, wherein a selective plurality of displacement outputs are used to estimate the sensor offset, the displacement offsets being selected by comparing a magnitude of the displacement offset against a predetermined threshold.

59. The method of claim 58, wherein estimating the sensor offset further comprises taking an average value of the stored displacement outputs.

60. The method of claim 1, wherein measuring comprises measuring the axial position of the movable body when it is levitating.

G1

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

61. A magnetically suspended pump apparatus, comprising:

a housing comprising an inlet port and an outlet port for receiving and discharging fluid respectively;

a rotor positioned within the housing for pumping blood between the housing's inlet port and outlet port;

a plurality of permanent magnets for passively controlling the radial position of the rotor radially, and the pitch and yaw of the rotor;

an electromagnet for actively controlling the position of the rotor in the axial direction;

an electromagnetic motor for rotating the rotor about a central axis;

a sensor for measuring the axial displacement of the rotor;

an offset compensation module for adjusting an output of the sensor to account for sensor offset;

a rotor position controller for positioning the rotor at the point of substantial axial equilibrium; and

an actuator for creating an electromagnetic force to position the rotor.

62. The pump apparatus of claim 61, further comprising a computer comprising memory for storing and recalling sensor data.

63. The pump apparatus of claim 62, wherein the computer controls the operation of the pump apparatus.

64. The pump apparatus of claim 62, wherein the computer in configured to recall saved sensor data upon reboot or reset of the computer.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

65. The pump apparatus of claim 61, wherein the position controller is configured to balance the passively controlled forces acting on the rotor.

66. The pump apparatus of claim 61, wherein the rotor position controller is a virtual zero power controller.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101

a1

67. A method of positioning a magnetically suspended rotor in a pump apparatus, the pump apparatus comprising at least one permanent magnet, at least one electro magnet, a rotor position sensor, and a rotor position controller, comprising:

measuring the displacement of the rotor in a plurality of positions to produce a plurality of displacement output;

estimating a sensor offset using the displacement outputs;

adjusting the displacement output by the estimated sensor offset to create an adjusted displacement output;

inputting the adjusted displacement output into the rotor position controller configured to determine the point of substantial axial equilibrium of the rotor; and

converting the output of the rotor position controller into a force for positioning the rotor.

MADSON & METCALF, P.C.
ATTORNEYS AT LAW
900 GATEWAY TOWER WEST
15 WEST SOUTH TEMPLE
SALT LAKE CITY, UTAH 84101